Climate Variability, Hydrology, and Flooding

Remote Sensing Observations for Flood Modeling

Objective

Learn to access NASA remote sensing and modeling data for input to hydrology/flood models

Outline

- Review of Hydrological Parameters Relevant to Flood Modeling

- Weather Data for Hydrology Modeling

- Terrain Data for Hydrology Modeling

Review of Hydrological Parameters Relevant to Flood Modeling

NASA Satellites and Atmosphere-land Models Provide Data for Inputs to Hydrology Models

❑ Rainfall   TRMM

❑ Weather Data: Temperature, Winds, Humidity   MERRA

❑ Soil Moisture   GLDAS/TMI/SMAP

❑ Terrain   Shuttle Radar Topography Mission

❑ Land Cover   Terra/Aqua MODIS

Information and Access of These Data was Covered in Session-2

NASA Satellites and Atmosphere-land Models Provide Data for Inputs to Hydrology Models

❑ Rainfall	TRMM
❑ Weather Data: Surface Temperature, ❑ Winds, Humidity	MERRA
❑ Soil Moisture	GLDAS/TMI/SMAP
❑ Terrain	Shuttle Radar Topography Mission
❑ Land Cover	Terra/Aqua MODIS

This Session will focus on MERRA and SRTM Data and Access

Weather Data for Hydrology Modeling

Modern Era Retrospective-analysis for Research and Applications (MERRA)
http://gmao.gsfc.**nasa**.gov/**merra**

What is Reanalysis?

- A technique to produce multiple climate variables with a value added merger of many types of observations with the latest Earth systems models

- Past observations of basic meteorological data such as temperature, wind speed, and pressure are analyzed and interpolated onto model grids

- 3-D forecasting model is initialized and constrained with the observations. The model simulations provide many climate variables which are not observed, for example moisture flux

- The model simulations also provide more frequent (hourly, 6-hourly) outputs than observations

MERRA Blends the vast quantities of observational data with output data of the Goddard Earth Observing System (GEOS) model [1979-present]

The Changing Observing System
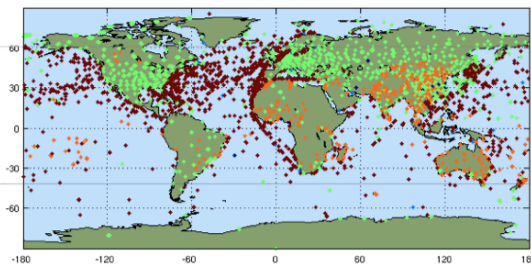
1973 – 77K Obs every 6hrs
1987 – 550K Obs every 6hrs
1979 – 325K Obs every 6hrs
2006 – 4.2M Obs every 6hrs
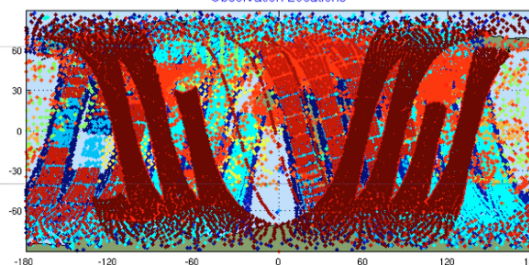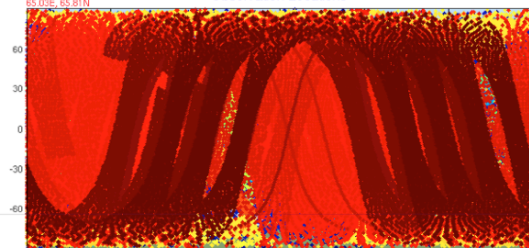
As the observing system improves, modeling uncertainties decrease

Current satellite coverage assimilated in MERRA

Observations Used in MERRA Reanalysis

MERRA focuses on historical analyses on a broad range of weather and climate time scales (hours to years) and places the NASA satellite observations in a climate context
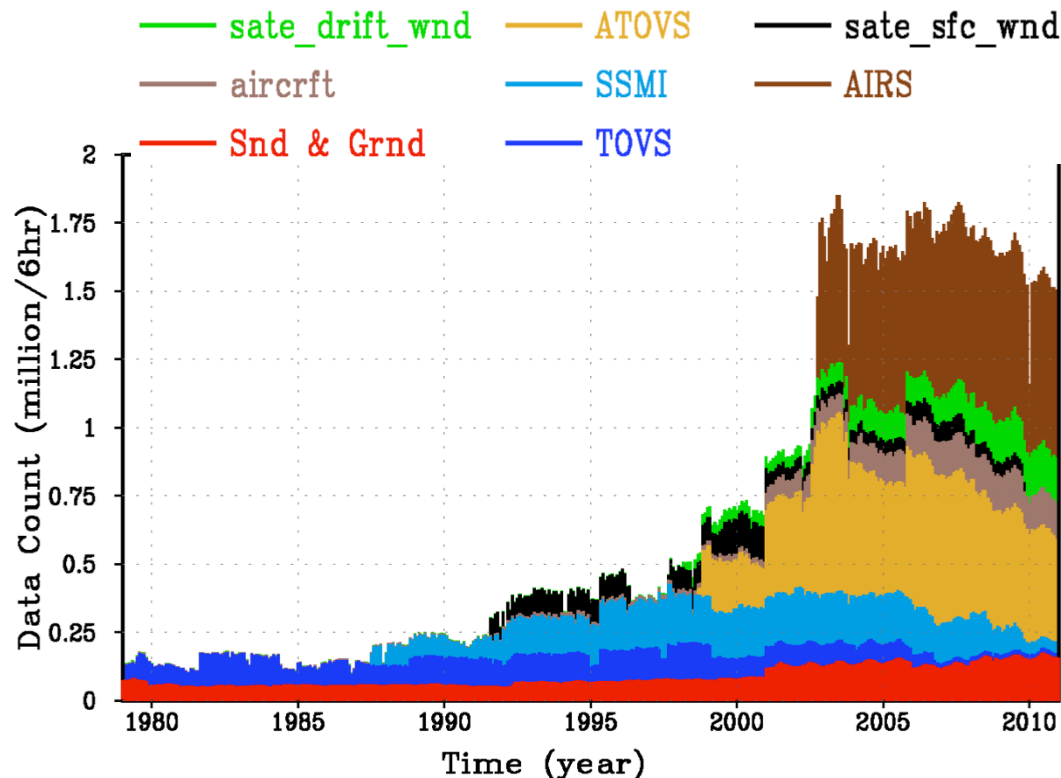
- Technologies change; Instrument life cycle

From: Michael Bosilovich, NASA-GSFC-GMAO

MERRA Weather Data for Hydrology Modeling

Parameters (Latitude-longitude-Height/Pressure Levels)*

Temperature
East-West and North-South Wind Components
Specific Humidity and Relative Humidity

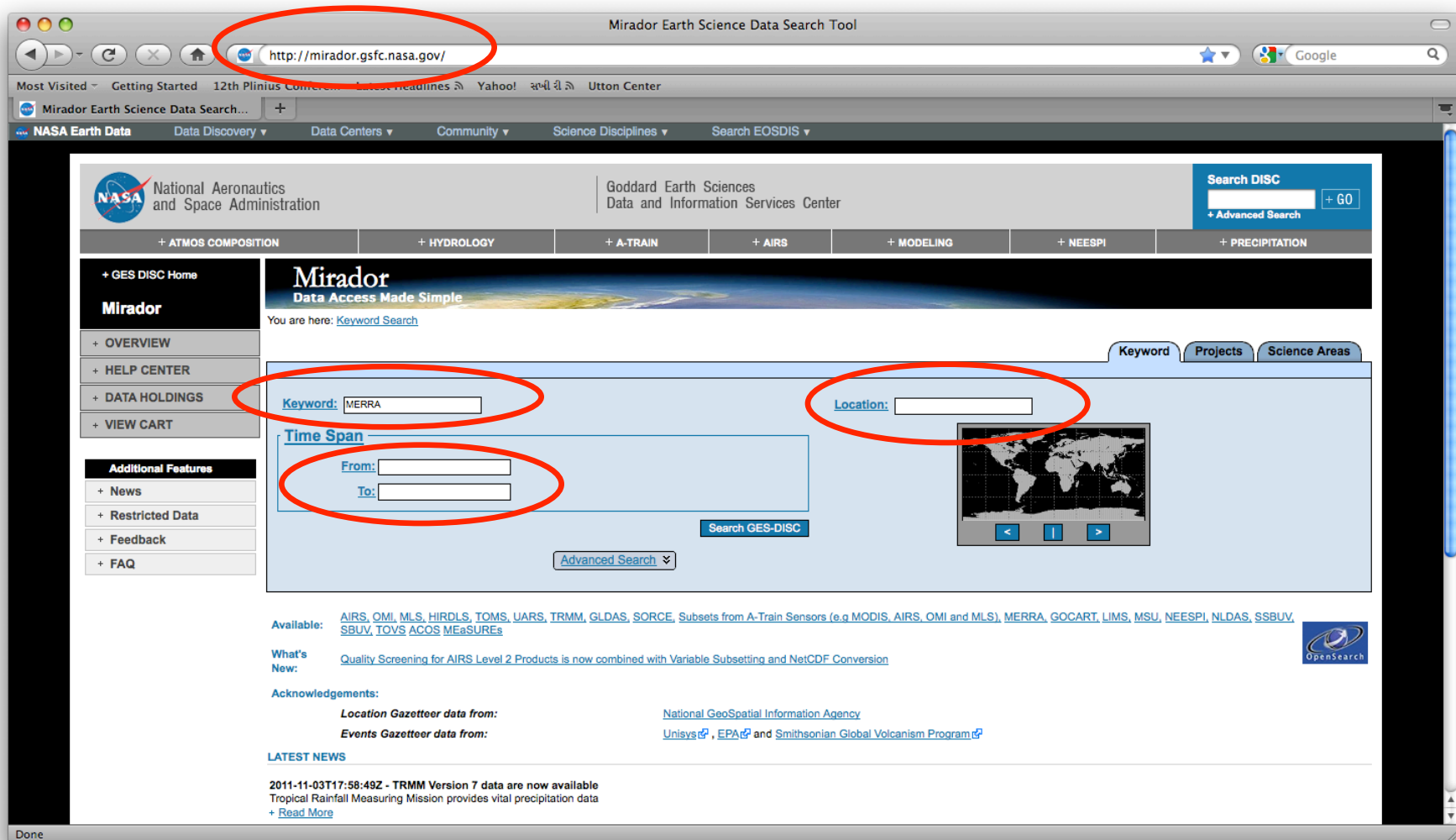Spatial Resolution: 1.25°x1.25° and 42 vertical levels
Spatial Coverage: Global

Temporal Resolution: Hourly, Monthly
Temporal Coverage: 1979-Present

MERRA Data Access

Data can be downloaded from http://mirador.gsfc.nasa.gov by a keyword search. Also, can search by time and location/region

Terrain Data for Hydrology Modeling

From Shuttle Radar Topography Mission (SRTM)

USGS

NASA

Sources of NASA Terrain Data

Radar: Shuttle Radar Topography Mission (SRTM)

Radiometer: Terra Advanced Spaceborne Thermal Emission
                                    and Reflection
Radiometer (ASTER)

Useful for Mapping
Hazardous terrain
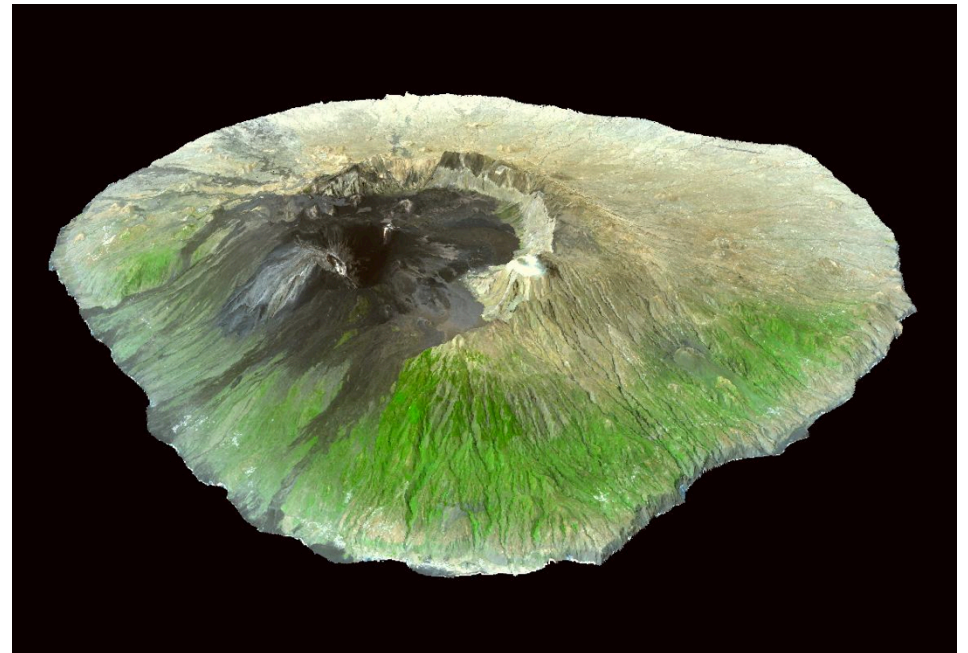**Calculating**
Slope and aspect
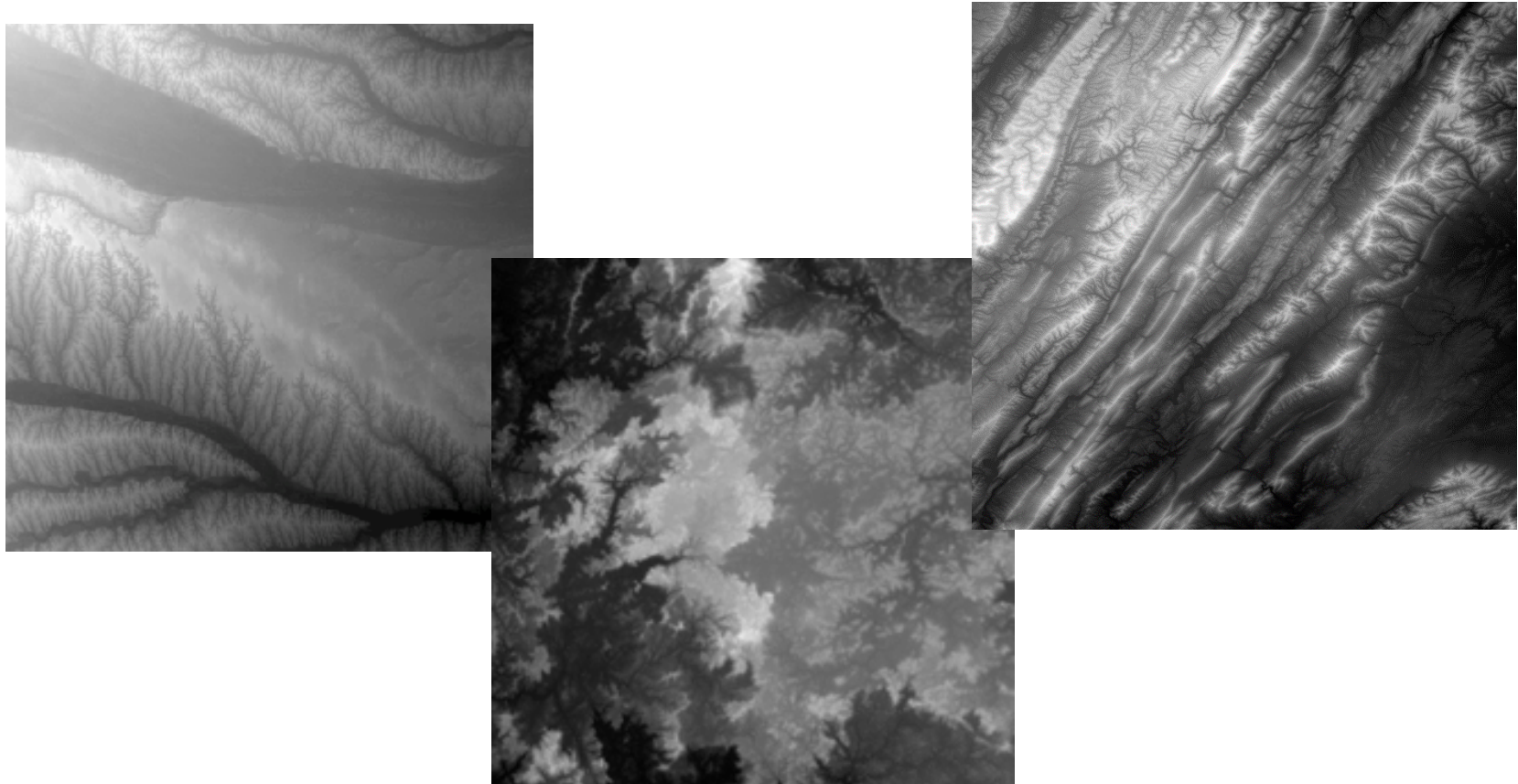Catchment area
Forest canopy height
Modeling
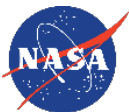Runoff
Stream networks
Landslides

Shuttle Radar Topography Mission (SRTM)
Version 3.0 (SRTM Plus)

https://lpdaac.usgs.gov/products/measures_products_table
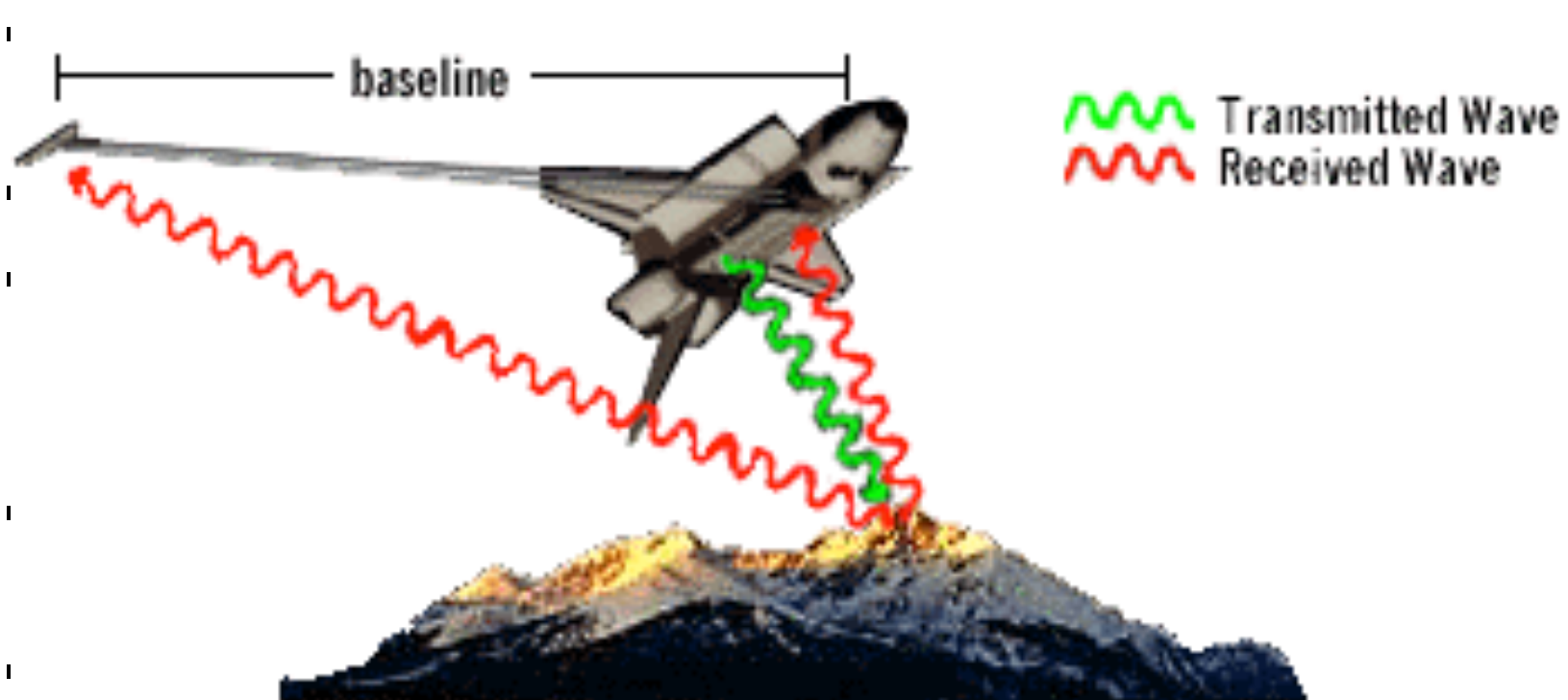
USGS NASA

What is SRTM?

- NASA mission completed in February 2000
- Consisted of 176 orbits around Earth in 11 days
- Acquired Digital Elevation Model (DEM) of all land between 60°N and 56°S latitude, about 80% of Earth's total land mass

NASA SRTM Version 3.0 (SRTM Plus)

Radar signals being transmitted and recieved in the SRTM mission
(image not to scale).

http://srtm.usgs.gov/data/interferometry.php

NASA SRTM v3 Characteristics

Tile size	1° by 1°
Pixel size	1 arc second (~30 meters) ⟵ New version released in 2014 has high resolution or 3 arc seconds (~90 meters)
Geographic coordinates	Geographic latitude and longitude
Output format	DEMS: .HGT, 16-bit signed integer, in units of vertical meters Number: .NUM
Geoid reference	WGS84/EGM96
Special DN values	N/A - No voids in v3
Coverage	60°N to 56°S latitude ⟵ U.S. and Territories Africa

NASA SRTM v3 Products

Short Name	Collection	MEaSUREs Data Product	Spatial Resolution
SRTMGL1	SRTM	SRTM Global 1 arc second	1 arc-second
SRTMGL1N	SRTM	SRTM Global 1 arc second number	1 arc-second
SRTMGL3	SRTM	SRTM Global 3 arc second	3 arc-second
SRTMGL30	SRTM	SRTM Global 30 arc second	30 arc-second
SRTMGL3N	SRTM	SRTM Global 3 arc second number	3 arc-second
SRTMGL3S	SRTM	SRTM Global 3 arc second sub-sampled	3 arc-second
SRTMSWBD	SRTM	SRTM Water Body Data Shapefiles & Raster Files	1 arc-second
SRTMUS1	SRTM	SRTM US 1 arc second	1 arc-second
SRTMUS1N	SRTM	SRTM US 1 arc second number	1 arc-second

Sampling Methods: Global 3 arc second data

Sampled data
-Higher resolution
(~100 meters)
-More noise
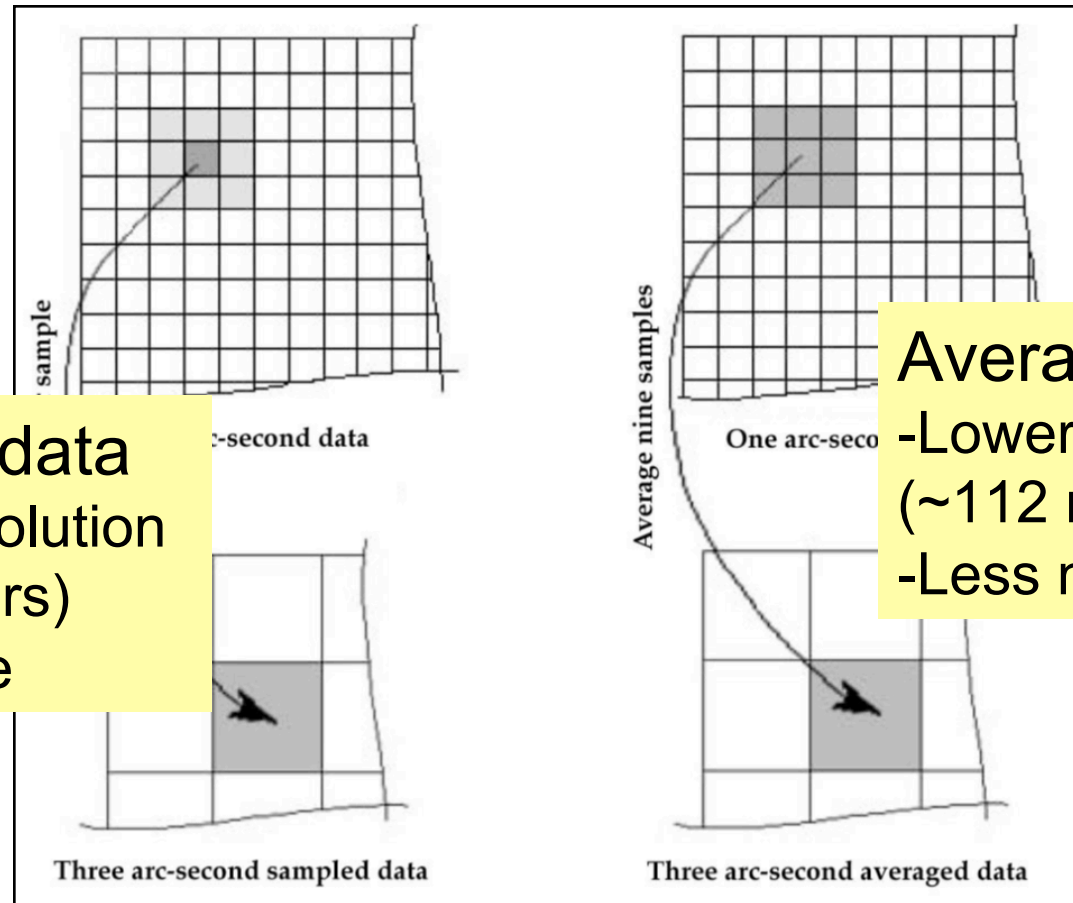
Averaged data
-Lower resolution
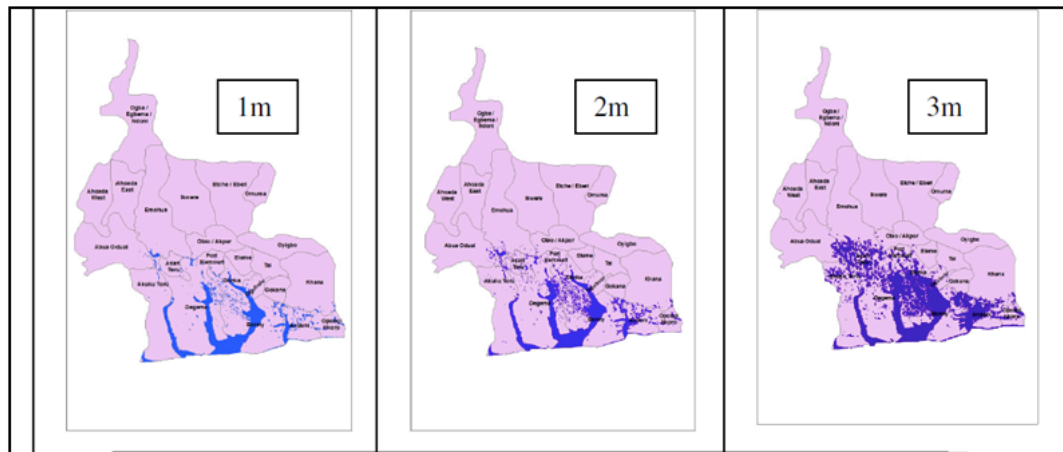(~112 meters)
-Less noise

SRTM Data Use Case

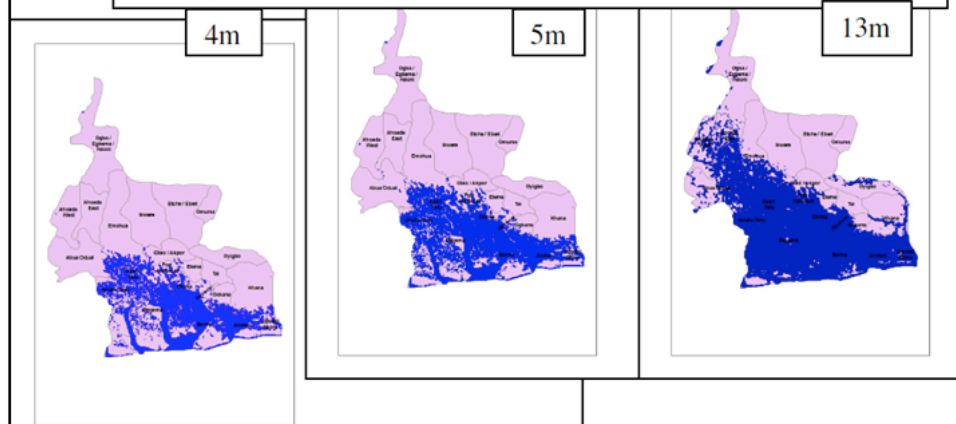Fig 3.4. Potential LGA areas of Flooding for 1m, 2m and 3m Sea rise

Fig 3.5 Potential LGA areas of flooding for 4m, 5m and 13m sea rise scenarios

Sea Level Rise Scenarios (m)	Affected Local Government Areas
1	10
2	12
3	12
4	13
5	13
13	22

Onwuteaka, J., 2014, GIS Modeling of Flooding Exposure in Nigerian Coastal Areas from Sea Level Rise, Journal of Environment and Earth Science v. 4, no. 12, p. 81-94.

How to Access NASA SRTM v3

- Reverb:
  http://reverb.echo.nasa.gov/reverb

- GDEx:
  http://gdex.cr.usgs.gov/gdex/

- Data Pool and DAAC2Disk:
  https://lpdaac.usgs.gov/data_access/data_pool

- More information: SRTM v3 User Guide
  https://lpdaac.usgs.gov/sites/default/files/public/measures/docs/
  NASA_SRTM_V3.pdf

Global Data Explorer (GDEX)
http://gdex.cr.usgs.gov/gdex/

- Funded through NASA ROSES 2005 ACCESS Program

- A collaboration between the LP DAAC and George Mason University's Center for Spatial Information Science and Systems

- A seamless data viewer providing access to multiple sources of digital elevation data sets

- Users can subset and download data by area of interest in multiple formats and projections
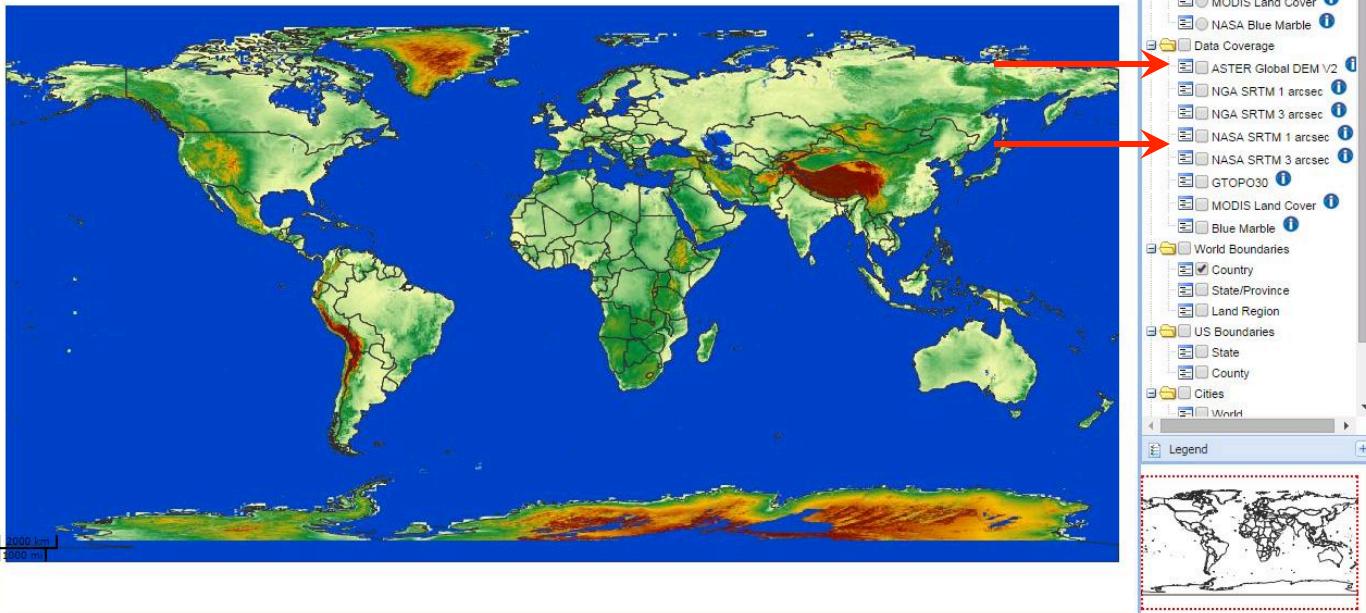
GDEx

GDEx Features and Functions

- NASA ECHO/Reverb user account required to download data

- Product documentation and User Guide

- Square or polygonal area of interest

- Pre-defined areas of interest (state, county)

- Advanced, on-the-fly processing
    - Mosaic tiles coverage clipped to area of interest
  - Reformat to GeoTIFF, ArcASCII, or JPEG
  - universal transverse Mercator (UTM) or LAT/LON projection

- Preview data before download

GDEx Tile Limits

1 degree x 1 degree
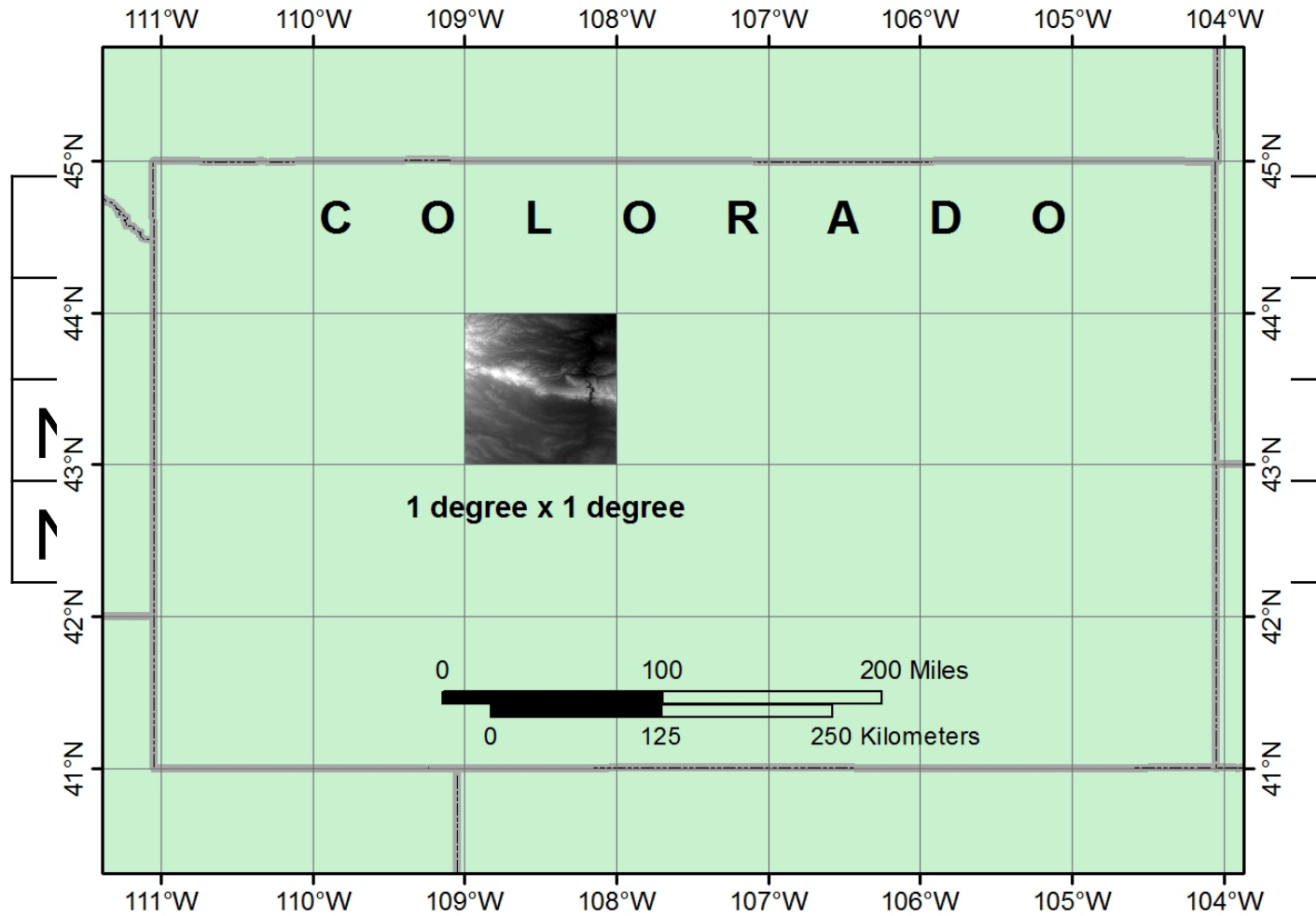
Summary

Data for Hydrology Model Inputs

Quantity	Source	Access
Rainfall	TRMM TMPA GPM IMERG (In 2016)	Giovanni (Also TMPA Near-real-Time data from IRI Climate Data Library)
Weather Parameters (Temperature, Humidity, Winds)	MERRA	Mirador
Soil Moisture	GLDAS SMAP (In 2016)	Mirador, Giovanni NSIDC
Land Cover	Terra and Aqua/MODIS	Reverb
Terrain	SRTM	Reverb, GDEx

Next:

Overview of

TRMM-based Flood Monitoring Tools